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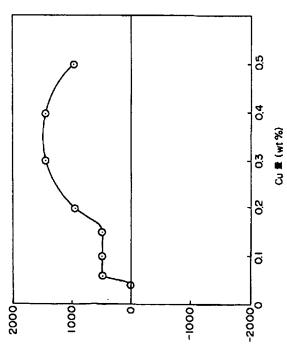
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#### (54) 【発明の名称】 超高張力電鏈鋼管の製造方法

### (57)【要約】

【課題】引張強度が高く、耐水素遅れ割れ特性に優れた、またはこれに加えて耐食性にも優れた超高張力電縫鋼管の製造方法を提供すること。

【解決手段】重量で、C:0.10~0.19%、Si:0.01 ~0.5% Mn:0.8~2.2%、Al:0.01~0.06%、Nb:0.005~0.03%、B:0.0005~0.0030%を含み、P:0.02%以下、S:0.003%以下、N:0.004%以下、Ti:0.015%以下である鋼スラブを1150~1300℃で均熱した後、Ar,点以上を仕上温度とし、500~650℃で巻取って熱延鋼帯とし、酸洗冷圧後、連続焼鈍炉で800~900℃に均熱加熱後急冷し、さらに150~250℃で焼戻し処理を行い、この鋼帯を1000≤Q/(t/D)²≤3000を満たす幅絞り率Qで造管し、超高張力電縫鋼管を得る。ただし、Q=[{鋼板の幅-π(D-t)}/π(D-t)]×100、t(mm):板厚、D(mm): 鋼管外径。



水素遅れ割れ発生膜界付加受み変化量 (μm)

#### 【特許請求の範囲】

【請求項1】 重量%で、C:0.10~0.19%、  $Si:0.01\sim0.5\%$ ,  $Mn:0.8\sim2.2\%$ , A1:0. 01 $\sim$ 0. 06%, Nb:0. 005 $\sim$ 0. 03%, B: 0.  $0005\sim0$ . 0030%, P: 0. 02%以下、S:0.003%以下、N:0.005% 以下、Ti:0.015%以下、及び実質的に残部Fe 及び不可避的不純物からなる鋼スラブを1150~13 00°Cで均熱した後、とのスラブに対してAr, 点以上 を仕上温度とする熱間圧延を施し、500~650℃で 10 る。 巻取って熱延鋼帯とし、この熱延鋼板を酸洗冷圧後、連米

Q=[{鋼板の幅- $\pi$ (D-t)}/ $\pi$ (D-t)]×100 …… (2)

【請求項2】 さらに、重量%で、Cu:0.05~ 0.50%を含み、Ni:0.1%以下であることを特 徴とする請求項1に記載の超高張力電縫鋼管の製造方 法。

#### 【発明の詳細な説明】

[0001]

【発明の属する技術分野】本発明は、ドアインパクトビ ームなどの自動車用部材、さらには機械構造用部材、土 20 木建築用部材に用いられる超髙張力電縫鋼管およびその 製造方法に関する。

[0002]

【従来の技術】自動車などの車両ドア内部には、安全性 の観点からドアインパクトビームと呼ばれる補強材が設 けられている。従来のドアインパクトビームには、高張 力冷延鋼板のプレス成型品が用いられることが多かった が、近年、軽量化のために、引張強度が980N/mm ' 以上の著しく強度の高い高張力電縫鋼管が採用される ようになってきている。

[0003]

×

[0006]

【発明の実施の形態】本発明の超高張力電縫鋼管は、鋼 の成分組成および組織を制御することによりはじめて達 成されるものである。本発明の第1実施形態および第2 実施形態はそのために特定の成分組成の鋼板の熱処理条 件および造管条件等を規定するものであり、第3実施形 態は鋼の成分組成および組織自体を規定するものであ

【0007】(1)第1実施形態(化学組成)引張強度 が980N/mm'以上で、しかも優れた耐水素遅れ割 れ特性を得るために、C:0.10~0.19%、S  $i:0.01\sim0.5\%$ , Mn:0.8~2.2%, A  $1:0.01\sim0.06\%$ , Nb:0.005~0.0 3%、B:0.0005~0.0030%を含み、さら にP:0.02%以下、S:0.003%以下、N: 0.005%以下、Ti:0.015%以下に制限した 組成に規定する。また、Cu:0.05~0.50%が 選択成分として添加される。その場合に、Niを添加す 50 る。

\* 続焼鈍炉で800~900℃に均熱加熱後急冷し、さら に150~250℃で焼戻し処理を行い、得られた鋼板 を以下の(1)式を満たす幅絞り率Qで造管し、80~ 100%焼戻しマルテンサイト+残部フェライト組織よ りなる引張強度980N/mm'以上の電縫鋼管を得る ことを特徴とする超高張力電縫鋼管の製造方法。  $1000 \le Q/(t/D)^2 \le 3000 \cdots (1)$ ただし、 t (mm): 鋼板の板厚、 D (mm): 電縫鋼管の外 径、Q(%)は幅絞り率で、以下の式(2)で定義され

※【発明が解決しようとする課題】上記特開平1-205032 号、特開平4-131327号、特開平4-187319号、特開平6-57 375 号、特開平6-88129 号、特開平6-179913号の各公報 などに示された方法は、造管に伴い残留歪みが存在する ため、その実用に際しては水素遅れ割れに対する配慮が 必要である。

[0004]

【課題を解決するための手段】本発明者らは、前記目的 を達成するために多くの実験的検討を行った結果、鋼成 分の調整、および鋼板の熱処理条件および造管条件を適 正化して組織を調整するととにより耐水素遅れ割れ特性 に優れた、またはこれに加えて耐食性にも優れた超高張 力電縫鋼管を得ることが可能となるという知見を得た。 [0005]

 $1000 \le Q/(t/D)^2 \le 3000 \cdots (1)$ ただし、 t (mm): 鋼板の板厚、 D (mm): 電縫鋼管の外 径、Q(%)は幅絞り率である。幅絞り率Q(%)は以 30 下の式(2)で定義される。

 $Q = [{鋼板の幅-\pi(D-t)}/\pi(D-t)] \times 100 \cdots (2)$ 

ることがあるが、Ni:0.10%以下とする。 【0008】C: Cは所望のマルテンサイトを生成さ せ、目標とする強度を確保するために必須な元素であ る。しかし、含有量が0.10%未満であると目標とす る980N/mm2以上の強度が得られず、一方、含有 量が0.19%を超えると、引張強度が高くなりすぎる か、あるいは焼戻し時に析出する炭化物サイズが大きく 40 なり、いずれにせよ耐水素遅れ割れ特性が劣化する。し たがってCの含有量を0.10~0.19%とする。 【0009】8: Sは介在物として存在し、耐水素遅 れ割れ特性を劣化させるため、0.003%以下に規制 することが必要である。

【0010】Ti: Tiは粗大な窒化物として析出す ると、
耐水素遅れ割れ特性を低下させるので、添加しな いことが望ましい。しかし、固溶NをTiNとして固定 し、Bの焼入れ性を確保するためにやむなく添加する場 合には、その添加量を0.015%以下とする必要があ

[0011]

 $1000 \le Q/(t/D)^2 \le 3000 \cdots (1)$ 

ただし、 t (mm): 鋼板の板厚、 D (mm): 電縫鋼管の外 \*

Q=[{鋼板の幅- $\pi$ (D-t)}/ $\pi$ (D-t)]×100 …… (2)

る。

図3にQ/(t/D)2と水素遅れ割れ発生限界付加歪 みΔεc の関係を示す。本発明者らは造管条件と耐水素 遅れ割れ特性に関する多くの実験的検討を行った結果、 図3に示すように、鋼管の水素遅れ割れ発生限界付加歪 みは幅絞り率Qが1000(t/D)2~3000(t

/ D) \* の間でピークを持ち、幅絞り率をこの範囲に制※10 【0012】

 $\Delta \varepsilon = (4 \cdot 106 \cdot t \cdot \delta) / (\pi \cdot D \cdot (D - t)) \cdots (3)$ 

ことで、t は板厚、Dは切出し前の鋼管の外径、δはD - (付加歪み付加後の外径)である。

【0013】Cr: Mnとの相互作用により鋼の焼入 性を上げ、目標とする強度を確保するための元素であ る。その含有量が0.05%未満であるとその効果が乏 しく、一方0.6%を超えると耐水素遅れ割れ特性が劣 化する。したがって、Crの含有量を0.05~0.6 %とする。

【0014】Nb、V: Nb, Vはいずれも変態前の オーステナイト粒を微細化し、変態後のマルテンサイト パケットを微細化することができるので、耐水素遅れ割 れ特性の向上に好ましい元素である。しかし、それぞれ 0.005%未満ではその効果は少なく、一方0.03 %を超えて添加すると、耐水素遅れ割れ特性がかえって 劣化する。したがって、Nb、Vの含有量をそれぞれ 0.005~0.03%とする。

【0015】C: Cは所望のマルテンサイトを生成さ せ、目標とする強度を確保するために必須な元素であ ★ 厚/外径) 比により異なり、優れた耐水素遅れ割れ特性 を有する鋼管を得るためには(板厚/外径)比どとに異 なる幅絞り率をとる必要がある。

※御することで優れた耐水素遅れ割れ特性を有する鋼管が

得られることを見出した。この適正幅絞り率は製品(板

\*径、Q(%)は幅絞り率で、以下の式(2)で定義され

★る。しかし、含有量が0.13%未満であると目標とす る1180N/mm'以上の強度が得られず、一方、含 有量が0.19%を超えると、水素遅れ割れ、あるいは 腐食による管体強度低下が助長され、耐久性が劣化す る。したがってCの含有量を0.13~0.19%とす

【0016】浸漬試験後のTS(N/mm²)=浸漬試 験後の引張破断荷重(N)/浸漬試験前の管断面積(m 20 m<sup>2</sup>)

である。

[0017]

【実施例】以下、本発明の実施例について説明する。 【0018】(実施例1)表1に示すA~Fの6種の鋼 を溶製し、表2に示すように本発明で規定した熱延条 件、連続焼鈍炉における熱処理条件、造管条件にて3 8 m m φ × 1. 6 m m t の電縫鋼管を作製した。 [0019]

【表1】

		_		_ {	<u>.</u>	学	啟	分		(#t%	၈			
	С	S i	Мn	P	S	A 1	Νb	Cu	Νi	Τi	В	N		
A	0.12	0. 38	1. 40	0. 01	0.001	0. 03	0. 015	tr	tr	0. 011	0.0008	0.003	790	
В	0.15	0.42	1.01	0. 01	0.003	0.04	0.012	tr	tr	0.009	0.0012	0.003	780	発
C	0.17	0. 39	1. 33	0. 01	0.002	0. 03	0. 015	0. 33	tr	tr	0.0018	0.002	760	舅
D	0. 17	0. 40	L 40	0.01	0.002	0. 03	0. 013	tr	tr	0. 008	0.0012	0. 003	760	材
E	0. 17	0.41	1. 35	0.01	0.001	0. 03	0. 013	0. 20	tr	0. 010	0.0011	0. 003	760	
														比
F	0. 23	0. 41	1.90	0.01	0. 002	0.03	tr	tr	tr	tr	tr	0.004	750	岐
L				L		<u> </u>			L					材

[0020]

【表2】

	_												U
	番		*	NE GP	Þ		美帕炉 理条件		達	管条件	÷	ミクロ 組 機	
-		Ar3	加熱	仕上	色取	加熱	焼戻し	板厚	外径	<b>₩</b> }‡		マルテンタイト	
	号		型皮	銀度	盔皮	温度	祖庆	t	D	Q	Q/	分車	
		(°C)	(°C)	(°C)	(°C)	(C)	(°C)	(100)	(==)	(%)	(t/D)2	(%)	
A	1	790	1240	830	630	890	200	1.6	31. 8	4.9	1940	100	
В	2	780	1230	860	620	860	190	1.6	31. 8	4.9	1940	100	
C	3	760	1200	870	610	840	220	1.6	31.8	4.9	1940	100	発明的
D	4	760	1180	850	590	850	220	1.6	31.8	4.9	1940	100	
E	5	760	1210	860	580	870	210	1.6	31. 8	4.9	1940	100	
F	6	750	1250	860	610	880	220	1.6	31.8	4.9	1940	100	比较例

[0021]

【表3】

\*【0022】 【表4】

	黃	引張特性	三点曲げ特性	耐水素遅れ割れ特性	
1		TS	最大荷置	割れ発生限界付加	1
	号	(MPa)	(kW)	歪み、Δε(μ)	
Λ	1	1210	12. 1	2140	
В	2	1380	14.0	2140	1
С	3	1490	14.8	3330	発明例
D	4	1510	15. 6	2140	
E	5	1500	15.5	3100	
F	6	1720	17. 5	0	比較例

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*													
			Ħ	<b>夏延条</b> 作	<b>†</b>		美美炉		造	音条件	‡	ミクロ	
_	_		4				理条件					組織	
<b>M</b>		Ar3	加熱	仕上	卷取	加热	焼戻し	板厚	外径	<b>₽</b> }\$	3	マルテンナイト	
	号		温度	温度	温度	温度	温度	ŧ	D.	Q	Q/(t/D) <sup>2</sup>	分率	
Ш		(°C)	(°C)	(℃)		(°C)	(°C)	(88)	(ma)	(%)		(%)	
	7		1200	860	520	880	220	2.0	31.8	6.0	1520	100	発明例
Α	8	790	1160	850	580	890	240	2.0	31.8	6.0	1520	100	
	9	150	1230	850	670	880	220	2.0	31. 8	6.0	1520	100	比較例
	10		1220	840	590	890	180	2.0	31.8	2.0	510	100	
	11		1210	830	600	810	210	1.6	38. 1	2.0	1130	90	
	12		1170	850	600	870	230	1.8	31.8	4.8	1500	100	発明何
В	13	780	1180	820	590	860	180	20	31.8	8. 2	2070	100	
	14		1120	830	600	860	190	2.0	31.8	8. 2	2070	700	比較例
l	15		1280	750	620	880	200	2.0	31.8	6.0	1520	100	
	16		1220	830	580	860	200	1.6	31. 8	4.8	1900	100	癸明倒
c	17	760	1250	820	570	840	220	20	31.8	9.0	2280	100	
١	18	'**	1250	830	550	760	210	1.6	31.8	4.8	1900	100	比較例
	19		1240	860	560	850	190	2.0	38.1	9.0	3270	100	
	20		1250	840	610	860	210	1.6	31. 8	3. 2	1250	100	発明例
Ь	21	760	1230	880	600	870	210	2.0	31.8	6.0	1520	100	203,01
٦	22	1 .~	1180	870	600	940	230	1.6	31.8	3. 2	1260	100	比較例
	23		1190	830	540	850	340	2.0	31.8	6.0	1520	100	
Г	24		1210	850	580	860	200	1.6	38.1	5.2	2950	100	
	25		1210	840	560	880	200	1.8	31.8	6.0	1870	100	発明例
l	26		1230	850	620	870	230	2.0	38.1	2.8	1020	100	JE 70 //3
E	27	760	1210	880	630	860	220	2.0	31.8	5.2	1310	100	
1	28	1	1240	860	590	870	20	1.6	31.8	2.8	1110	100	
	29		1200	860	590	860	200	1.8	31.8	9.8	3060	100	比较何
1	30		1190	840	550	850	230	2.0	31.8	2.8	710	100	

[0023]

【表5】

\*【0024】 【表6】

	香	引張特性	三点曲げ特性	耐水素遅れ割れ特性	
無		TS	最大简重	割れ発生限界付加	
	9	(MPa)	(kW)	歪み、Δε (μ)	
	7	1220	11. 0	2140	発明例
	8	1280	13.6	2140	,,,,,,,
	9	1180	12. 9	950	比較例
L.	10	1240	9. 8	950	
	11	1060	17.0	2380	
	12	1290	14.7	2140	発明例
В	13	1350	16.8	2140	L
1	14	1320	14. 2	950	比較例
L	15	1390	16.6	950	
İ	16	1480	22. 1	3330	発明例
l c	17	1420	17. 3	3330	
	18	890	24. 3	3330	比较例
	19	1510	17. 9	950	
	20	1520	22. 1	2140	発明例
D	21	1490	17. 3	2140	
	22	1480	24. 3	950	比較例
L	23	1500	17. 9	950	
	24	1530	15.4	3100	
1	25	1510	15.1	3100	発明例
	26	1470	16.4	3100	
E	27	1480	16.9	3100	
	28	1430	18.4	950	
1	29	1410	17.6	480	比較例
L	30	1500	18.2	950	

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鲷				- 1	Ł	学	成	分		(vt9	6)		備考
	С	Si	Mn	P	\$	A 1	Cr	Cu	Ni	ИР	٧	N	,
G	0. 12	0.42	1. 90	0.01	0.002	0.03	0.47	0. 02	0. 01	0.000	0.000	0. 003	
H	0.15	0.41	1.51	0.01	0. 003	0.04	0.42	0. 30	0.02	0.000	0.000	0. 003	
I	0. 15	D. 40	1.80	0. 01	0.002	0.03	0. 46	0. 01	0, 01	0.010	0.000	0.004	発明材
J	0.18	0. 38	1.79	0.01	0.002	0.03	0. 46	0. 01	0.01	0.000	0. 000	0. 003	
L	0.18	0. 41	1.81	0.01	0.001	0.03	0.44	0. 22	0. 01	0.000	0.000	0. 003	
K	0. 23	0. 40	1.82	0.01	0.002	0.03	0. 02	0. 01	0.02	0.000	0. 000	0.003	比較材

[0025]

# ※ ※【表7】

				<i>R</i> 3	延 3	k #			遊貨	条件	<b>;</b>	粗量	
#	番	Ar 3		30%						輻較		焼戻し	
	号	温度	仕上	压下	冷却	保持	卷取	板厚	外径	り率	Q/	マルテンサイト	情 考
			湿度	温度	速度	時間	温度	t	D	Q	(t/D) <sup>2</sup>	分率	
		(°C)	<b>(C)</b>	&	℃/\$	(a)	(°C)	(mm)	(100)	(%)		(%)	
G	1	820	900	925	130	2.5	80	2.3	34.0	6.5	1420	100	
н	2	810	910	940	120	2.3	70	2. 3	34. 0	6.5	1420	100	Ì
ī	3	810	880	905	125	2.8	60	2.3	34.0	6.5	1420	100	発明的
7	4	800	890	915	110	2.3	70	2.3	34. 0	6. 5	1420	100	
K	5	800	870	890	115	2.3	50	2.3	34.0	6.5	1420	100	
L	6	790	890	910	120	2.1	50	2.3	34.0	6. 5	1420	100	比較例

[0026]

【表8】

	番	引强特性	耐水素運れ割れ特性	
鋼		TS	割れ発生服界付加	借考
	号	(N/=2)	歪み、Δε (μ)	
A	1	1180	1900	
В	2	1360	2860	
C	3	1390	1900	発明例
D	4	1480	1900	
E	5	1500	2380	
F	6	1640	0	比較例

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\*【0027】 【表9】

\*

1	·			顤	延 弟	6 件			进 管	条件	<b> </b>	組織	
# 1	*	Ar3		30%						幅校		焼戻し	
	号	温度	性上	胜下	冷却	保持	卷取	板厚	外径	り字	Q/	7877911	曹 考
- 1	- 1		温度	湿皮	速度	時間	直庆	t	D	Q	(t/D) <sup>2</sup>	分事	
- 1		(°C)	9	(2)	℃/s	(s)	(C)		(mm)	(%)		96	
	7		850	870	90	2.3	70	2.3	38.1	3.9	1070	85	発明例
G	8	820	890	915	120	2.7	_80	2.3	31.8	8.2	1568	100	ועוניטנ
٦	9	020	960	920	50	2.5	60	2.3	38.1	3.9	1070	60	比較例
	10		920	940	120	2.5	70	2.3	31.8	4.8	918	100	HARLES
$\neg \neg$	11		860	890	93	2.2	80	3. 2	31.8	11.8	1165	100	
[	12		B50_	875	125	2.0	90	2.3	34.0	10.5	2295	100	発明例
Н [	13	810	850	870	95	2.1	60	3. 2	38.1	7. 5	1063	100	
[	14		810	830	90	2.3	100	2.3	38.1	3. 9	1070	60	比較例
[	15		940	955	130	2.7	60	2.3	31.8	8.2	1568	100	PURKPI
	16		860	880	120	3.2	70	23	38. 1	3.9	1070	100	発明例
ı, [	17	810	880	900	85	2.0	60	3.2	31.8	11.8	1165	100	TE TIVE
ı <b>'</b> [	18	910	890	910	105	2.1	90	2.3	38.1	11.8	3238_	100	比较例
	19	l	860	880	80	>2.0	190	3.2	31.8	11.8	1165	*1	JUAN PT
	20	I	890	915	120	2.3	80	2.3	38.1	3.9	1070	100	
i [	21	1	900	930	115	2.7	70	2.0	34.0	9.5	2746	100	発明例
	22		900	930	110	2.1	60	2.0	34.0	6.5	1879	100	369300
1	ឌ	800	900	925	110	2.4	60	2,3	31.8	8.2	1568	100	
	24		880	910	105	1.1	80	2.3	38.1	3. 9	1070	<b>\$2</b>	
	ĸ	]	860	910	110	2.1	70	2.0	34.0	6.5	1879	100	比較例
	26		890	910	100	2.1	60	2.0	38.1	9.6	3484	100	
	27		900	925	120	2. 2	60	2.3	34.0	6.5	1420	100	発明例
к	28	800	850	880	105	2.1	80	2.0	31.8	7.2	1820	100	76-71173
	29	] 000	860	880	105	1.3	80	2.0	34.0	6.5	1879	<b>*</b> 2	比较例
	30	<u> </u>	840	865	90 F1 0 09	2.2	100 2: <b>#</b>	2.3	31.8	3.9	746 ( h 1 0 09	100	ALTAY)

【0028】 【表10】

11

	#	引張特性	耐水素温れ割れ特性	
#		TS	割れ発生既界付加	推考
	号	(N/=2)	歪み、Δε (μ)	
	7	1040	1900	発明例
G	8	1210	1900	
	9	810	1900	比較例
	10	1120	950	
	11	1410	2860	
	12	1360	2860	発明例
н	13	1320	2860	]
	14	870	2860	比較例
	15	1340	950	
	16	1270	1900	発明例
١,	17	1360	1900	
_	18	1420	950	比較例
L	19	940	1900	
	20	1480	1900	
	21	1490	1900	発明例
	22	1510	1900	
3	23	1520	1900	
1	24	1510	950	
	25	1500	950	比較例
l	26	1570	950	
	27	1480	2380	発明例
K	28	1510	2380	
"	29	1530	950	比较例
	30	1490	950	

\*【0029】 【表11】

10

20

\*

(vt. %) Si Mn P S Al Nb Cu Cr Ni No Тi В С M | 0. 15 | 0. 35 | 1. 78 | 0. 01 | 0. 005 | 0. 03 | 0. 015 | 0. 22 | 0. 02 | tr | tr | tr 0.002 N 0. 15 0. 36 1. 40 0. 02 0. 003 0. 02 0. 014 0. 40 0. 01 tr 0. 01 | 0. 001 | 0. 003 tr 0 0. 17 | 0. 41 | 1. 80 | 0. 01 | 0. 005 | 0. 03 | 0. 020 | 0. 16 | 0. 01 | tr 0.004 99 tt tr 0. 17 | 0. 33 | 1. 35 | 0. 01 | 0. 001 | 0. 03 | 0. 016 | 0. 15 tr tr 0.01 0.001 0.002 tr Q 0. 17 0. 41 1. 82 0. 01 0. 002 0. 03 0. 14 | 0. 42 | tr | tr | 0. 01 | 0. 001 | 0. 003 tr 0.17 0. 40 | 1. 50 | 0. 01 | 0. 003 0. 03 tr tr 0.03 tr tr tr tr 0.003 比 較 0. 37 1. 90 0.01 0.002 0.03 0.03 17 17 0.003 94

[0030] [表12]

α	スラブ→無延(インライン焼入れ焼戻し)→スリット→造管
ß	スラブ→無延→連続焼鈍(インライン焼入れ焼戻し)→スリット→造質
7	スラブ→無延→冷延→連続旋阵(インライン焼入れ焼戻し)→スリット→造管
δ	スラブ→無延→スリット→造資→統入れ換戻し
ε	スラブ→無延→冷延→焼鉢→スリット→造管→焼人れ焼戻し

## [0031]

\* \* 【表13】

			マルテンサイト	浸渍試験的	浸渍試験後	孩留發皮率	-
香号		製造方法	分率	ØTS	ØΤS	~= ~~	
			(%)	(N/ma²)	(N/m²)	(%)	
1	M	α	8 0	1 2 20	1040	85	
2	M	7	100	1420	1180	8 3	
3	М	ő	100	1400	1200	8 6	
4	N	a	8 0	1410	1300	92	
5	N	7	100	1 2 30	1110	90	
6	N	δ	100	1380	1210	8.8	
7	0	a	100	1530	1250	82	
8	0	7	100	1520	1260	83	発明例
9	0	δ	100	1 4 70	1180	80	
10	0	ε	100	1550	1260	81	
11	P	a	100	1 4 5 0	1190	8 2	
12	P	β	100	1 5 20	1260	83	
13	P	7	100	1550	1240	80	
14	P	δ	100	1540	1260	8 2	
15	Q	α	100	1560	1260	8 1	
16	Q	8	100	1530	1250	82	<u></u>
17	R	α	100	1380	990	7 2	
18	R	β	100	1 4 20	1040	7 3	}
19	R	7	100	1500	1110	7 4	
20	R	ð	100	1510	1120	7 4	比較例
21	R	2	100	1500	1080	7 2	
22	s	a	80	1320	920	70	
23	5	7	100	1570		遅れ破壊割れ	]
24	S	δ	100	1550	1010	6.5	

### [0032]

### 【図面の簡単な説明】

【図1】Cu添加量と割れ発生限界付加歪み変化量との関係を示す図。

【図2】Ni添加量と割れ発生限界付加歪み変化量との関係を示す図。

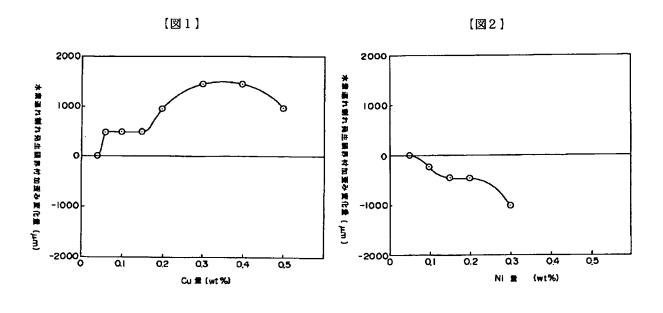
【図3】Q/(t/D)<sup>2</sup> と水素遅れ割れ発生限界付加 歪みとの関係を示す図。

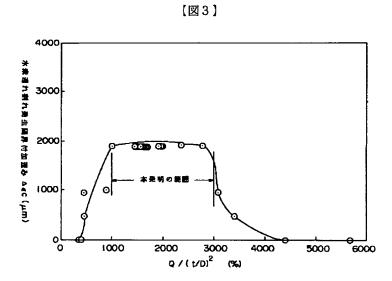
【図4】 $150\sim250$   ${\mathbb C}$ の温度範囲における保持時間と水素遅れ割れ発生限界付加歪み $\Delta\epsilon$ 、との関係を示す

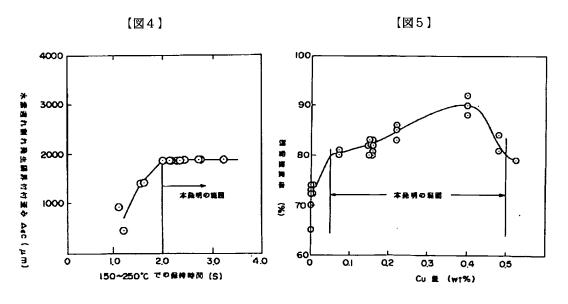
【図5】Cu添加量と腐食試験後の残留強度率の関係を示す図。

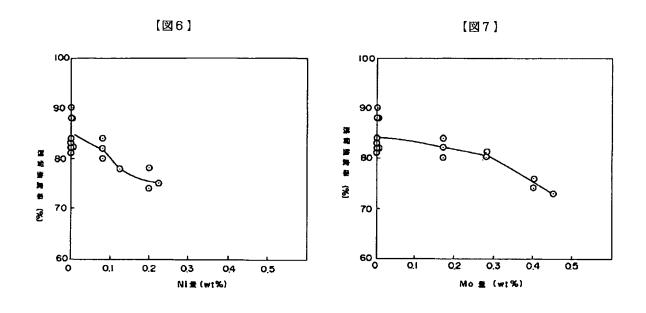
【図6】Ni添加量と腐食試験後の残留強度率の関係を示す図。

【図7】Mo添加量と腐食試験後の残留強度率の関係を示す図。









フロントページの続き

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#### **CLAIMS**

#### [Claim(s)]

[Claim 1] By weight %, C:0.10 - 0.19%, Si:0.01-0.5%, Mn: 0.8-2.2%, aluminum:0.01-0.06%, Nb:0.005-0.03%, B:0.0005 - 0.0030%, P:0.02% or less, S:0.003% or less, After carrying out soak of less than [ Ti:0.015% ] and the steel slab which consists of the remainder Fe and an unescapable impurity substantially at 1150-1300 degrees C N:0.005% or less, It is Ar3 to this slab. The hot rolling which makes beyond a point finishing temperature is performed. It rolls round at 500-650 degrees C, and considers as a hot-rolling steel strip. This hot rolled sheet steel After the acidwashing cold press, Quench after soak heating at 800-900 degrees C with a continuous annealing furnace, and tempering processing is performed at further 150-250 degrees C. The manufacture approach of the super-high tension electroseamed steel pipe characterized by obtaining a with an or more [ 980Ns //mm ] 2 tensile strength which forms the obtained steel plate by width-of-face contraction percentage Q which fills the following (1) types, and consists of a 80 - 100% tempered martensite + remainder ferrite electroseamed steel pipe. 1000 <=Q/(t/D)2 <=3000 .... (1)

However, board thickness of a t(mm):steel plate, D (mm): The outer diameter of an electroseamed steel pipe and Q (%) are width-of-face contraction percentages, and are defined by the following formulas (2).

 $Q=[/pi(D-t)] \times 100 \dots (2) [\{width-of-face-pi(D-t) of a steel plate pi\}]$ 

[Claim 2] Furthermore, the manufacture approach of the super-high tension electroseamed steel pipe according to claim 1 characterized by being less than [ nickel:0.1% ] by weight % including Cu:0.05-0.50%.

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#### **DETAILED DESCRIPTION**

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the member for automobiles, the super-high tension electroseamed steel pipe further used for a machine structural element and an engineering-works structural member, and its manufacture approaches, such as a door impact beam.

[0002]

[Description of the Prior Art] The reinforcing materials called a door impact beam from a viewpoint of safety are prepared in the interior of car Doat, such as an automobile. Although the press cast of cold rolled high tensile strength steel sheets was used for the conventional door impact beam in many cases, tensile strength is 2 980Ns/mm because of recent years and lightweight-izing. The above remarkable high tension electroseamed steel pipe with high reinforcement is adopted increasingly.

[0003]

[Problem(s) to be Solved by the Invention] Since residual distortion exists with tubulation, consideration of as opposed to a hydrogen delay crack on the occasion of the practical use is required for the approach shown in each official report of above-mentioned JP,1-205032,A, JP,4-131327,A, JP,4-187319,A, JP,6-57375,A, JP,6-88129,A, and JP,6-179913,A etc. [0004]

[Means for Solving the Problem] In order to attain said object, as a result of performing many experimental examination, or this invention persons were excellent in the hydrogen-proof delay crack property by rationalizing the heat treatment conditions and tubulation conditions of adjustment of a steel component, and a steel plate, and adjusting an organization, they acquired the knowledge of becoming possible to obtain the super-high tension electroseamed steel pipe which was excellent also in corrosion resistance in addition to this. [0005]

1000 <=Q/(t/D)2 <=3000 .... (1)

However, board thickness of a t(mm):steel plate, D (mm): The outer diameter of an electroseamed steel pipe and Q (%) are width-of-face contraction percentages. Width-of-face contraction percentage Q (%) is defined by the following formulas (2).

Q=[/pi(D-t)] x100 .... (2) [ {width-of-face-pi (D-t) of a steel plate pi} ] [0006]

[Embodiment of the Invention] The super-high tension electroseamed steel pipe of this invention is begun and attained by controlling a component presentation and organization of steel. the 1st operation gestalt and the 2nd operation gestalt of this invention — therefore, heat treatment conditions, tubulation conditions, etc. of a steel plate of a specific component presentation are specified, and the 3rd operation gestalt specifies a component presentation and the organization itself of steel.

[0007] (1) The 1st operation gestalt (chemical composition) tensile strength is 2 980Ns/mm. Above In order to acquire the outstanding hydrogen-proof delay crack property, and C:0.10 - 0.19%, Si: 0.01-0.5%, Mn:0.8-2.2%, aluminum:0.01-0.06%, Nb: Specify to the presentation restricted

to less than [ Ti:0.015% ] including 0.005–0.03% and B:0.0005 – 0.0030% further P:0.02% or less, S:0.003% or less, and N:0.005% or less. Moreover, Cu:0.05–0.50% is added as a selection component. In that case, although nickel may be added, it may be less than [ nickel:0.10% ]. [0008] C: C is an indispensable element, in order to make desired martensite generate and to secure target reinforcement. However, 980N/mm2 made into a target for a content to be less than 0.10% The above reinforcement is not obtained, but on the other hand, if a content exceeds 0.19%, tensile strength will become high too much, or the carbide size which deposits at the time of annealing will become large, and a hydrogen–proof delay crack property will deteriorate anyway. Therefore, the content of C is made into 0.10 – 0.19%.

[0009] S: In order for S to exist as inclusion and to degrade a hydrogen-proof delay crack property, to regulate to 0.003% or less is required.

[0010] Ti: If Ti deposits as a big and rough nitride, since it will reduce a hydrogen-proof delay crack property, not adding is desirable. However, Dissolution N is fixed as TiN, and in order to secure the hardenability of B, to add reluctantly, it is necessary to make the addition into 0.015% or less.

[0011]

1000 <=Q/(t/D)2 <=3000 .... (1)

However, board thickness of a t(mm):steel plate, D (mm): The outer diameter of an electroseamed steel pipe and Q (%) are width-of-face contraction percentages, and are defined by the following formulas (2).

Q=[/pi(D-t)] x100 .... (2) [ {width-of-face-pi (D-t) of a steel plate pi} ]

It is Q/2 (t/D) to drawing 3. Hydrogen delay crack generating marginal addition distortion deltaepsilonc Relation is shown. As a result of this invention persons' performing many experimental examination about tubulation conditions and a hydrogen-proof delay crack property, as shown in drawing 3, for the hydrogen delay crack generating marginal addition distortion of a steel pipe, width-of-face contraction percentage Q is 1000(t/D) 2 -3000(t/D) 2. It had a peak in between and found out that the steel pipe which has the hydrogen-proof delay crack property excellent in controlling a width-of-face contraction percentage in this range was obtained. This proper width-of-face contraction percentage is a product (board thickness/outer diameter). In order to obtain the steel pipe which changes with ratios and has the outstanding hydrogen-proof delay crack property (board thickness/outer diameter) It is necessary to take a different width-of-face contraction percentage for every ratio.

[0012]

deltaepsilon=(4, 106, and t-delta)/(pi-D- (D-t)) .... (3)

Here, t is [ the outer diameter of the steel pipe before logging and delta of board thickness and D ] D- (outer diameter after addition distortion addition).

[0013] Cr: It is an element for securing raising and target reinforcement by the interaction with Mn. [ hardenability / of steel ] If the effectiveness is scarce in the content being less than 0.05% and it exceeds 0.6% on the other hand, a hydrogen-proof delay crack property will deteriorate. Therefore, the content of Cr is made into 0.05 - 0.6%.

[0014] Nb, V: Since each of Nb(s) and V can make the austenite grain before a transformation detailed and the martensite packet after a transformation can be made detailed, it is an element desirable to improvement in a hydrogen-proof delay crack property. However, at less than 0.005%, if there is little the effectiveness and it adds exceeding 0.03% on the other hand, a hydrogen-proof delay crack property will deteriorate on the contrary, respectively. Therefore, the content of Nb and V is made into 0.005 – 0.03%, respectively.

[0015] C: C is an indispensable element, in order to make desired martensite generate and to secure target reinforcement. However, 1180N/mm2 made into a target for a content to be less than 0.13% The above reinforcement is not obtained, but on the other hand, if a content exceeds 0.19%, the shell lowering on the strength by the hydrogen delay crack or corrosion will be promoted, and endurance will deteriorate. Therefore, the content of C is made into 0.13 – 0.19%. [0016] The tubing cross section before the \*\*\*\* (breaking load N) / immersion test after TS (N/mm2) = immersion test after an immersion test (mm2) It comes out.

# [0017]

[Example] Hereafter, the example of this invention is explained.

[0018] (Example 1) Six sorts of steel of A-F shown in a table 1 was ingoted, and the electroseamed steel pipe of 31.8mmphix1.6mmt was produced on the hot-rolling conditions specified by this invention as shown in a table 2, the heat treatment conditions in a continuous annealing furnace, and tubulation conditions.

# [0019]

## [A table 1]

				{	Ł	#	啟	ЭÌ		(wt9	ဂ			
	С	Si	Мa	P	S	A 1	Νb	Cu	NI	Ti	В	N		
A	0.12	0.38	1.40	0. 01	0.001	0. 03	0.015	tr	tr	0. 011	0.0008	0. 003	790	
В	0.15	0.42	1.01	0. 01	0.003	0.04	0.012	tr	tr	0.009	0. 0012	0.003	780	発
С	0.17	0.39	1. 33	0.01	0.002	0.03	0. 015	0. 33	tr	tr	0.0018	0.002	760	明
D	0.17	0.40	L 40	0.01	0.002	0.03	0. 013	tr	tr	0.008	0.0012	0. 003	760	材
E	0. 17	0.41	1. 35	0.01	0.001	0.03	0.013	0. 20	tr	0. 010	0. 0011	0.003	760	
														比
F	0. 23	0.41	1.90	0.01	0.002	0.03	tr	tr	tr	tr	tr	0.004	750	較
L														材

# [0020]

# [A table 2]

	番		Я	NESP	<b>‡</b>		焼鈍炉 理条件		造	管条件	<b>+</b>	ミクロ 組 機	
鯛		Ar3	加熱	仕上	色取	加加	幾戻し	板草	外径	<b>GE</b> 9#		マルテンタイト	
1	号		温度	程度	温度	湿度	祖皮	t	D	Q	<b>Q</b> /	分率	
		(°C)	(°C)	(°C)	(°C)	(70)	9	<u> </u>	( <b>34</b> )	(%)	(t/D) <sup>2</sup>	<b>O</b> 60	
Α	1	790	1240	830	630	890	200	1.6	31. 8	4.9	1940	100	
В	2	780	1230	860	620	890	190	1.6	31. 8	4.9	1940	100	
С	3	760	1200	870	610	840	220	1.6	31.8	4.9	1940	100	発明例
D	4	760	1180	850	590	850	220	1.6	31.8	4.9	1940	100	
E	5	760	1210	860	580	870	210	1.6	31.8	4.9	1940	100	
F	6	750	1250	860	610	880	220	1.6	31.8	4.9	1940	100	比較例

# [0021]

## [A table 3]

	香	引張特性	三点曲げ特性	耐水素遅れ割れ特性	
49		TS	最大荷堂	割れ発生限界付加	
L	号	(MPa)	(kW)	歪み、Δε (μ)	
Λ	1	1210	1 2. 1	2140	· ·
В	2	1380	14.0	2140	ĺ
С	3	1490	14.8	3330	発明例
ם	4	1510	15.6	2140	
E	5	1500	15. 5	3100	
F	6	1720	17.5	0	比較例

## [0022]

[A table 4]

				e de la company	<b>‡</b>	連載	美鈍炉		海	<b>*</b> & #	Ł	ミクロ	
					•	悪処	理条件		~	# <i>7</i> =-, ;	•	組織	
痹	#	Ar3	加熱	生上	卷取	加熱	焼戻し	板厚	外径	(1)年		214741	
l	号		温度	湿度	温度	湿度	湿度	t	ם	Q	Q/(t/D) <sup>2</sup>	分串	
		(°C)	(°C)	(℃)	(°C)	(°C)	(%)	(m)	(2023)	(%)		(%)	
	7		1200	860	520	880	220	20	31.8	6.0	1520	100	発明例
A	8		1150	850	580	890	240	2.0	31. 8	6.0	1520	100	, , , , ,
	8	790	1230	850	670	880	220	2. D	31.8	6.0	1520	100	比較例
	10		1220	840	590	890	180	2.0	31.8	20	510	100	
	11		1210	830	600	810	210	1.6	38. 1	2.0	1130	90	
	12		1170	850	600	870	230	1.8	31.8	4.8	1500	100	発明例
В	13	780	1180	820	590	860	180	2.0	31.8	8.2	2070	100	
	14		1120	830	600	860	190	20	31.8	8.2	2070	100	比較例
L	15		1280	750	620	880	200	2.0	31.8	6.0	1520	100	
	16		1220	830	580	860	200	1.6	31.8	4.8	1900	100	発明例
c	17	760	1250	820	570	840	220	2.0	31.8	9.0	2280	100	
	18	'	1250	830	550	760	210	1.6	31. 8	4.8	1900	100	比较例
L_	19		1240	860	560	850	190	2.0	38, 1	9.0	3270	100	
l	20		1250	840	610	860	210	1.6	31. 8	3. 2	1260	100	発明例
D	21	760	1230	880	600	870	210	2.0	31. 8	6.0	1520	100	20707
1	22		1180	870	600	940	230	1.6	31. 8	3. 2	1260	100	比較例
L	23		1190	830	540	850	340	2.0	31. 8	8. Q	1520	100	
	24		1210	850	580	860	200	1.6	38.1	5. 2	2950	100	
	25		1210	840	560	880	200	1.8	31.8	6.0	1870	100	発明例
	26		1230	850	620	870	230	2.0	38.1	2.8	1020	100	-27303
E	27	760	1210	880	630	860	220	2.0	31. 8	5. 2	1310	100	
1	28	1	1240	860	590	870	20	1.6	31.8	2.8	1110	100	
	28		1200	860	590	860	200	1.8	21. 8	9.8	3060	1 <b>0</b> 0	比較例
	30		1190	840	550	850	230	2.0	31.8	2.8	710	100	

[0023] [A table 5]

	季	引張特性	三点曲げ特性	耐水素遅れ割れ特性	
41		TS	最大荷堂	割れ発生限界付加	
	#	(MPa)	(kW)	歪み、Δε (μ)	
	7	1220	11.0	2140	発明例
	8	1280	13.6	2140	70,777
	9	1180	12.9	950	比較例
	10	1240	9. 8	950	
	11	1060	17.0	2380	
l	12	1290	14.7	2140	発明例
В	13	1350	16.8	2140	
	14	1320	14.2	9.50	比較例
	15	1390	16.6	950	
İ	16	1480	22. 1	3330	発明例
l c	17	1420	17. 3	3330	
	18	890	24. 3	3330	比較例
ᆫ	19	1510	17. 9	950	
l	20	1520	22. 1	2140	発明例
D	21	1490	17. 3	2140	
	22	1480	24.3	950	比較例
L	23	1500	17. 9	950	
1	24	1530	15.4	3100	
	25	1510	15.1	3100	発明例
1	26	1470	16.4	3100	1
E	27	1480	16. 9	3100	
	28	1430	18.4	950	
1	29	1410	17. 6	480	比較例
	30	1500	18. 2	950	L

# [0024] [A table 6]

<b>99</b>				- 1	Ł	*	成	分		(ut9	6)		備考
	U	Si	Мn	P	\$	Al	Cr	Сц	Ni	NЪ	v	N	, may⊃
G	0. 12	0.42	1. 90	0. 01	0. 002	0.03	0.47	0. 02	0.01	0.000	0. 000	0.003	
Н	0. 15	0.41	1. 51	0. 01	0. 003	0.04	0.42	0. 30	0.02	0.000	0.000	0. 003	
I	0. 15	0.40	1.80	0.01	0.002	0.03	0. 46	0. 01	0. 01	0.010	0. 000	0.004	発明材
J	0. 18	0. 38	1.79	0.01	0. 002	0.03	0. 46	0. 01	0.01	0.000	0. 000	0. 003	
L	0.18	0.41	1.81	0.01	0.001	0. 03	0. 44	0. 22	0.01	0.000	0. 000	0.003	
K	0. 23	Q. 40	1.82	0.01	0. 002	0.03	0. 02	0. 01	0.02	0. 000	0. 000	0. 003	比較材

# [0025] [A table 7]

				鳥	蒾 ś	5.件			造質	条件	<b>;</b>	粗糠	
鋼	番	AT 3		30%						幅紋		焼戻し	
	号	温度	仕上	ÆF	冷却	保持	卷取	板厚	外径	り率	Q/	マルテンサイト	青 考
			趣度	温度	速度	時間	温度	t	D	Q	(t/D) <sup>2</sup>	分零	
		(°C)	(°C)	(°C)	%/₽	(8)	(°C)	(ma)	(m)	ශා		(%)	
ø	1	820	900	925	130	2.5	80	2.3	34. 0	6.5	1420	100	
H	2	810	910	940	120	2. 3	70	2.3	34. 0	8.5	1420	100	
Ī	8	810	880	905	125	2.8	60	2.3	34.0	6.5	1420	100	発明例
J	4	800	890	915	110	2.8	70	2.3	34.0	6. 5	1420	100	
ĸ	5	800	870	890	115	2.3	50	2.3	34. 0	8. 5	1420	100	
L	6	790	890	910	120	2.1	50	2.3	34. 0	6. 5	1420	100	比较的

[0026] [A table 8]

	書	引張特性	耐水素差れ割れ特性	
4		ТS	割れ発生服界付加	備 考
	4	(N/== )	歪み、Δε(μ)	
A	1	1180	1900	
В	2	1360	2860	
С	3	1390	1900	発明例
D	4	1480	1900	
E	5	1500	2380	l
F	6	1640	0	比較例

[0027] [A table 9]

					4	r Ma	. 1		* 4	A 10		40 40	
_	_1			200	差点	£ ##	-	_	20 1			41 美	
#		Ar3		30%						權效	.,	焼灰し	
	号	温度	此	町	地型	保持	趣取	板厚	外径	り字	Ø/ ]	7/5794	鲁考
	- 1	-	主	ᇓ	遊文	時間	惑	1	D	Q	(t/D)*	分 率	
		8	<u> </u>	<u>(C)</u>	°C/s	(8)	(3)	(m)	(100)	(%)	1000	ଓଡ଼	
	7		850	870	90	2.3	70	2.3	38.1	3.9	1070	85	発明例
G	8	820	890	915	120	2.7	80	2.3	31.8	8.2	1568	100	ļ
Ť			900	920	50	2.5	60	2.8	38.1	3.9	1070	60	比較例
	5	<u> </u>	920	940	120	2.5	70	2.3	31.8	4.8	9)8	100	
1	11	1	860	890	90	2.2	80	3.2	31.8	11.8	1165	100	~
۱ ا	12	٠	B50	875	125	20	38	2.3	34,0	10.5	2295	100	癸劳罚
H	13	810	850	870	95	2.1	60	3.2	38.1	7.5	1063	100	
	14	ĺ	810	830	90	2.3	100	2.3	38.1	3.9	1070	60	比較例
	15		940	955	130	27	60	2.3	31.8	8.2	1588	100	
	16	1	860	880	120	3.2	70	23	38.1	3.9	1070	100	発明例
1	17	810	880	900	85	2.0	60	3.2	31.8	11.8	1165	100	
	18	-	890	910	105	21	90	2.3	38.1	11.8	3238	100	比較例
	19	ļ	860	880	80	>2.0	190	3.2	31.8	11.8	1165	*1	
	20	Į	890	915	120	2.3	80	23	38.1	3.9	1070	100	ļ
	21	1	900	930	115	2.7	70	2.0	34.0	9.5	2746	100	発明例
۱. ۱	22	٠	900	930	110	2.1	60	2.0	34.0	6.5	1879	100	
J	23	800	900	925	110	2.4	60	2.3	31.8	8, 2	1568	100	ļ
1	24	j	880	910	105	1.1.1	80	2.3	38, 1	3.9	1070	<b>\$2</b>	
1	25		860	910	110	2.1	70	2.0	34.0	6.5	1879	100	比較例
<u> </u>	26	<u> </u>	890	910	100	2.1	60	20	38.1	9.6	3484	100	
l	27	Į	900	925	120	2.2	50	2.3	34.0	6.5	1420	100	発明例
ĸ	28	800	850	880	105	2.1	80	2.0	31.8	7.2	1820	100	7071
1	29	ļ ***	860	880	105	1.3	80	2,0	34.0	6.5	1879	*2	比较例
<u> </u>	30	<u>L</u>	840	865 1 + 1	90 F1 0 05	2.2	2 - 100	2.3	31.8	3.9	746	100	

[0028] [A table 10]

	#	引張特性	耐水素連れ割れ特性	
無		TS	割れ発生限界付加	備考
	号	(N/m²)	歪み、Δε (μ)	
	7	1040	1900	発明例
G	8	1210	1900	,,,,,,
-	9	810	1900	比較例
	10	1120	950	
	11	1410	2860	
	12	1360	2860	発明例
Ħ	13	1320	2860	
	14	870	2860	比較例
Ĺ	15	1340	950	
	16	1270	1900	発明例
l.	17	1360	1900	
	18	1420	950	比較例
L	19	940	1900	
	20	1480	1900	
	21	1490	1900	発明例
	22	1510	1900	
ı	23	1520	1900	
l	24	1510	950	]
1	25	1500	950	比較例
L	26	1570	950	
	27	1480	2380	発明例
K	28	1510	2380	
	29	1530	950	比較例
L	30	1490	950	

# [0029] [A table 11]

(wt. %)

M	С	Si	Mn	P	s	A 1	Νb	Cu	Cr	Ni	lio	Тi	В	N	
М	0. 15	0. 35	L 78	0. 01	0. 005	0.03	0. 015	0. 22	0. 02	Ħ	tr	tr	tr	0. 002	
N	0. 15	0.36	1. 40	0. 02	0. 003	0. 02	0.014	0. 40	Q 01	q	tr	<b>0</b> . 01	0. 001	D. <b>00</b> 3	
0	0. 17	0. 41	1. 80	0.01	0. 003	0.03	0. 020	0, 16	0. 01	tr	tr	tr	tr	0. 004	
P	0. 17	0. 33	1. 35	0. 01	0. 001	0. 03	0. 016	0. 15	tr	tr	Ħ	0. 01	0. 001	0. 002	99
Q	Q. 17	0. 41	L 82	0. 01	0. 002	0.03	tr	0. 14	0. 42	Ħ	tr	0.01	D. 0 <b>0</b> 1	0. 003	
R	0.17	0. 40	1. 50	0. 01	0. 002	0. 03	म	tr	0. 03	ㅂ	tr	tr	tr	0. 003	
s	0. 23	0. 37	1. 90	0. 01	0. 002	0. 03	tr	tr	0. 03	ц	tr	tr	tr.	0. 003	飲例

[0030] [A table 12]

æ	スラブ→無逆(インライン焼入れ焼戻し)→スリット→造管
β	スラブ→無延→連続焼鈍(インライン換入れ焼戻し)→スリット→造管
7	スラブ <del>ー魚延→冷延→連続乾</del> 鈍(インライン焼入れ焼戻し)→スリット <del>→産</del> 管
δ	スラブ→無延→スリット→造管→焼入れ焼戻し
Ε	スラブー無延→冷延→焼鈍→スリット→直管→焼入れ焼戻し

[0031] [A table 13]

			マルテンサイト	浸渍試験前	浸渍試験後	<b>残留独皮率</b>	ï
香号		製造方法	分 率	ØTS	ØTS		
			(%)	(N/m²)	(N/m²)	(%)	
1	M	а	8 0	1 2 20	1040	8 5	
2	M	7	100	1420	1180	8.3	
3	M	8	100	1400	1200	8 6	
4	N	α	8 0	1410	1300	9 2	
5	N	7	100	1 2 30	1110	90	
6	N	ð	100	1380	1210	8.8	
7	0	æ	100	1 5 30	125¢	8 2	
8	0	7	100	1520	1260	8 3	発明例
9	0	δ	100	1470	1180	80	
10	0	ε	100	1550	1260	8 1	
11	P	α	100	1 4 5 0	1190	8 2	
12	P	β	100	1 5 20	1260	8 3	
13	P	7	100	1550	1240	8.0	
14	P	8	100	1540	1260	8 2	
15	Q	α	100	1560	1260	81	
16	Q	8	100	1530	1250	82	
17	R	α	100	1 3 80	990	7 2	
18	R	β	100	1 4 20	1040	7 3	
19	R	7	100	1500	1110	7 4	
20	R	δ	100	1510	1120	7 4	比較例
21	R	2	100	1500	1080	7 2	
22	s	a	8 0	1320	920	70	
23	S	7	100	1570		遅れ破壊割れ	
24	S	δ	100	1550	1010	6.5	<u></u>

## [0032]

[Effect of the Invention] Tensile strength 980N/mm2 which are used for autoparts, such as a door impact beam, a machine structural element, and an engineering—works structural member according to this invention as explained above The structural steel worker super—high tension electroseamed steel pipe excellent in the above hydrogen—proof delay crack property can be manufactured by low cost.

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#### **TECHNICAL FIELD**

[Field of the Invention] This invention relates to the member for automobiles, the super-high tension electroseamed steel pipe further used for a machine structural element and an engineering-works structural member, and its manufacture approaches, such as a door impact beam.

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#### PRIOR ART

[Description of the Prior Art] The reinforcing materials called a door impact beam from a viewpoint of safety are prepared in the interior of car Doat, such as an automobile. Although the press cast of cold rolled high tensile strength steel sheets was used for the conventional door impact beam in many cases, tensile strength is 2 980Ns/mm because of recent years and lightweight—izing. The above remarkable high tension electroseamed steel pipe with high reinforcement is adopted increasingly.

[0003]

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#### **EFFECT OF THE INVENTION**

[Effect of the Invention] Tensile strength 980N/mm2 which are used for autoparts, such as a door impact beam, a machine structural element, and an engineering—works structural member according to this invention as explained above The structural steel worker super—high tension electroseamed steel pipe excellent in the above hydrogen—proof delay crack property can be manufactured by low cost.

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### **TECHNICAL PROBLEM**

[Problem(s) to be Solved by the Invention] Since residual distortion exists with tubulation, consideration of as opposed to a hydrogen delay crack on the occasion of the practical use is required for the approach shown in each official report of above-mentioned JP,1-205032,A, JP,4-131327,A, JP,4-187319,A, JP,6-57375,A, JP,6-88129,A, and JP,6-179913,A etc.

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#### **MEANS**

[Means for Solving the Problem] In order to attain said object, as a result of performing many experimental examination, or this invention persons were excellent in the hydrogen-proof delay crack property by rationalizing the heat treatment conditions and tubulation conditions of adjustment of a steel component, and a steel plate, and adjusting an organization, they acquired the knowledge of becoming possible to obtain the super-high tension electroseamed steel pipe which was excellent also in corrosion resistance in addition to this.

[0005]

1000 <=Q/(t/D)2 <=3000 .... (1)

However, board thickness of a t(mm):steel plate, D (mm): The outer diameter of an electroseamed steel pipe and Q (%) are width-of-face contraction percentages. Width-of-face contraction percentage Q (%) is defined by the following formulas (2).

Q=[/pi(D-t)] x100 .... (2) [ {width-of-face-pi (D-t) of a steel plate pi} ]

[Embodiment of the Invention] The super—high tension electroseamed steel pipe of this invention is begun and attained by controlling a component presentation and organization of steel. the 1st operation gestalt and the 2nd operation gestalt of this invention — therefore, heat treatment conditions, tubulation conditions, etc. of a steel plate of a specific component presentation are specified, and the 3rd operation gestalt specifies a component presentation and the organization itself of steel.

[0007] (1) The 1st operation gestalt (chemical composition) tensile strength is 2 980Ns/mm. Above In order to acquire the outstanding hydrogen-proof delay crack property, and C:0.10 – 0.19%, Si: 0.01–0.5%, Mn:0.8–2.2%, aluminum:0.01–0.06%, Nb: Specify to the presentation restricted to less than [ Ti:0.015% ] including 0.005–0.03% and B:0.0005 – 0.0030% further P:0.02% or less, S:0.003% or less, and N:0.005% or less. Moreover, Cu:0.05–0.50% is added as a selection component. In that case, although nickel may be added, it may be less than [ nickel:0.10% ]. [0008] C: C is an indispensable element, in order to make desired martensite generate and to secure target reinforcement. However, 980N/mm2 made into a target for a content to be less than 0.10% The above reinforcement is not obtained, but on the other hand, if a content exceeds 0.19%, tensile strength will become high too much, or the carbide size which deposits at the time of annealing will become large, and a hydrogen-proof delay crack property will deteriorate anyway. Therefore, the content of C is made into 0.10 – 0.19%.

[0009] S: In order for S to exist as inclusion and to degrade a hydrogen-proof delay crack property, to regulate to 0.003% or less is required.

[0010] Ti: If Ti deposits as a big and rough nitride, since it will reduce a hydrogen-proof delay crack property, not adding is desirable. However, Dissolution N is fixed as TiN, and in order to secure the hardenability of B, to add reluctantly, it is necessary to make the addition into 0.015% or less.

[0011]

1000 <=Q/(t/D)2 <=3000 .... (1)

However, board thickness of a t(mm):steel plate, D (mm): The outer diameter of an electroseamed steel pipe and Q (%) are width-of-face contraction percentages, and are defined

by the following formulas (2).

Q=[/pi(D-t)] x100 .... (2) [ {width-of-face-pi (D-t) of a steel plate pi} ]

It is Q/2 (t/D) to <u>drawing 3</u>. Hydrogen delay crack generating marginal addition distortion deltaepsilonc Relation is shown. As a result of this invention persons' performing many experimental examination about tubulation conditions and a hydrogen-proof delay crack property, as shown in <u>drawing 3</u>, for the hydrogen delay crack generating marginal addition distortion of a steel pipe, width-of-face contraction percentage Q is 1000(t/D) 2 -3000(t/D) 2. It had a peak in between and found out that the steel pipe which has the hydrogen-proof delay crack property excellent in controlling a width-of-face contraction percentage in this range was obtained. This proper width-of-face contraction percentage is a product (board thickness/outer diameter). In order to obtain the steel pipe which changes with ratios and has the outstanding hydrogen-proof delay crack property (board thickness/outer diameter) It is necessary to take a different width-of-face contraction percentage for every ratio. [0012]

deltaepsilon=(4, 106, and t-delta)/(pi-D- (D-t)) .... (3)

Here, t is [ the outer diameter of the steel pipe before logging and delta of board thickness and D ] D- (outer diameter after addition distortion addition).

[0013] Cr: It is an element for securing raising and target reinforcement by the interaction with Mn. [ hardenability / of steel ] If the effectiveness is scarce in the content being less than 0.05% and it exceeds 0.6% on the other hand, a hydrogen-proof delay crack property will deteriorate. Therefore, the content of Cr is made into 0.05 – 0.6%.

[0014] Nb, V: Since each of Nb(s) and V can make the austenite grain before a transformation detailed and the martensite packet after a transformation can be made detailed, it is an element desirable to improvement in a hydrogen-proof delay crack property. However, at less than 0.005%, if there is little the effectiveness and it adds exceeding 0.03% on the other hand, a hydrogen-proof delay crack property will deteriorate on the contrary, respectively. Therefore, the content of Nb and V is made into 0.005 – 0.03%, respectively.

[0015] C: C is an indispensable element, in order to make desired martensite generate and to secure target reinforcement. However, 1180N/mm2 made into a target for a content to be less than 0.13% The above reinforcement is not obtained, but on the other hand, if a content exceeds 0.19%, the shell lowering on the strength by the hydrogen delay crack or corrosion will be promoted, and endurance will deteriorate. Therefore, the content of C is made into 0.13 – 0.19%. [0016] The tubing cross section before the \*\*\*\* (breaking load N) / immersion test after TS (N/mm2) = immersion test after an immersion test (mm2) It comes out.

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#### **EXAMPLE**

[Example] Hereafter, the example of this invention is explained.

[0018] (Example 1) Six sorts of steel of A-F shown in a table 1 was ingoted, and the electroseamed steel pipe of 31.8mmphix1.6mmt was produced on the hot-rolling conditions specified by this invention as shown in a table 2, the heat treatment conditions in a continuous annealing furnace, and tubulation conditions.

[0019]

### [A table 1]

				ſ	Ł	学	啟	分		(wt9	െ			
	С	Si	Мn	P	S	A 1	Nb	Cu	Νi	Ti	В	N		
A	0.12	0.38	1.40	0. 01	0. 001	0. 03	0. 015	tr	tr	0. 011	0.0008	0.003	790	
B	0. 15	0. 42	1. 01	0.01	0.003	0.04	0.012	tr	tr	0.009	0.0012	0.003	780	発
С	0.17	0. 39	1. 33	0.01	0.002	0.03	0.015	0. 33	Ħ	tr	0.0018	0.002	760	朔
D	0. 17	0. 40	1. 40	0.01	0.002	0.03	0.013	tr	tr	0.008	0.0012	0. 003	760	材
E	0. 17	0.41	1. 35	0.01	0.001	0.03	0.013	0.20	tr	0. 010	0. 0011	0.003	760	
														比
F	0. 23	0.41	1.90	0.01	0. 002	0.03	tr	tr	tr	tr	tæ	0.004	750	較
L		ļ									İ			材

## [0020]

# [A table 2]

	毒		#	NES#	þ		烧鲜炉 理条件		查	=	ミクロ 組 機		
無		Ar3	加熱	仕上	色取	加熱	焼戻し	板厚	外径	(日本)		7877941	
	号		湿度	温度	温度	湿度	祖皮	t	D	Q	<b>9</b> /	分率	
		(C)	(°C)	(°C)	(2)	(7)	(C)	(MA)	(200)	(%)	(t/D) <sup>2</sup>	(%)	
Α	1	790	1240	830	630	890	200	1.6	31.8	4.9	1940	100	
В	2	780	1230	860	620	880	190	1.6	31. 8	4.9	1940	100	
С	3	760	1200	870	610	840	220	1.6	31.8	4.9	1940	100	発明例
D	4	760	1180	850	590	850	220	1.6	31.8	4.9	1940	100	
E	5	760	1210	860	580	870	210	1.6	31.8	4.9	1940	100	
P	В	750	1250	860	610	880	220	1.6	31.8	4.9	1940	190	比較例

[0021]

[A table 3]

	書	引張特性	三点曲げ特性	耐水素遅れ翳れ特性	
鲷		TS	最大荷重	割れ発生限界付加	1
	号	(MPa)	(kW)	<b>歪み Δε (μ)</b>	
٨	1	1210	1 2. 1	2140	
В	2	1380	14.0	2140	
Ç	3	1490	14. 8	3330	発明例
D	4	1510	15.6	2140	
E	5	1500	15.5	3100	
F	в	1720	17. 5	0	比較例

# [0022] [A table 4]

		710 7											
			Ħ	延条件	<b>+</b>	連載	能鈍炉		造	管条件	<b>‡</b>	ミクロ	
						態処	短条件					組織	
舞	*	Ar3	加熱	性上	卷取	加熱	焼戻し	板摩	外径	1000年		マルテンティト	
	号		温度	温度	過度	温度	澄 度	t	D	Q	Q/(t/D) <sup>2</sup>	分率	
		(°C)	(°C)	(℃)	(℃)	(°C)	(3)	(mm)	(100)	(%)		(%)	
1	7		1200	860	520	880	220	20	31.8	6.0	1520	100	発明例
	8		1160	850	580	890	240	2.0	31.8	6.0	1520	100	) L // F1
	9	790	1230	860	670	880	220	2. D	31.8	6.0	1520	100	比較例
	10		1220	840	590	890	180	20	31.8	2.0	510	100	<b>AURAN</b>
	11		1210	830	600	810	210	1.6	38.1	2.0	1130	90	
	12		1170	850	600	870	230	1.8	31.8	4.8	1500	190	発明例
В	13	780	1180	820	590	860	180	2.0	31.8	8. 2	2070	100	
	14		1120	830	630	860	190	2.0	31.8	8. 2	2070	100	比较例
	15		1280	750	620	880	200	2.0	31. 8	6.0	1520	100	ACMAN 1
	16		1220	830	580	860	200	1.6	31.8	4. 8	1900	100	発明例
С	17	760	1250	820	570	840	220	2.0	31. 8	9. 0	2280	100	
	18		1250	830	550	760	210	1.6	31.8	4.8	1900	100	比較例
L	19		1240	860	560	850	190	20	38.1	9.0	3270	100	200.73
	20		1250	840	610	860	210	1.6	31. 8	3. 2	1260	100	発明例
D	21	760	1230	880	600	870	210	2.0	31. 8	6.0	1520	100	202301
	22		1180	870	600	940	230	1.6	31. 8	3. 2	1260	100	比較例
	23		1190	830	540	850	340	20	31. 8	8. 0	1520	100	~~,
	24		1210	850	580	860	200	1.6	38.1	5. 2	2950	100	
	25		1210	840	560	880	200	1.8	31.8	6.0	1870	100	発明例
	26	l	1230	850	620	870	230	2.0	38.1	28	1020	100	767383
E	27	760	1210	880	630	860	220	2.0	31.8	5. 2	1310	100	
	28	ĺ	1240	860	590	870	20	1.6	31.8	2.8	1110	100	
	29		1200	860	590	860	200	1.8	31. 8	9.8	3060	100	比較例
L	30	<u> </u>	1190	840	550	850	230	2.0	31.8	2.8	710	100	

[0023] [A table 5]

$\bigcap$	*	引强特性	三点曲げ特性	耐水素遅れ割れ特性	
<b>#</b>		TS	最大荷量	割れ発生限界付加	
	9	(MPa)	(k₩)	歪み、Δε (μ)	
	7	1220	11.0	2140	発明例
	8	1280	13.6	2140	753771
-	9	1180	12.9	950	比較例
	10	1240	9. 8	950	
	11	1060	17.0	2380	
	12	1290	14. 7	2140	発明例
В	13	1350	16.8	2140	
	14	1320	14. 2	950	比較例
	15	1390	16.6	950	~~,
	16	1480	22. 1	3330	発明例
c	17	1420	17. 3	3330	
	18	890	24. 3	3330	比較例
_	19	1510	17. 9	950	
	20	1520	22. 1	2140	莞明例
D	21	1490	17. 3	2140	,,,,,,
	22	1480	24.3	950	比較例
	<b>Z</b> 3	1500	17. 9	950	
1	24	1530	15.4	3100	
	25	1510	15.1	3100	発明例
	28	1470	16.4	3100	
E	27	1480	16.9	3100	
	28	1430	18.4	950	
	29	1410	17.6	480	比較例
L	30	1500	18.2	950	

# [0024] [A table 6]

				- 1	Ł	学	成	分		(et9	6)		40 2
	U	Si	Мп	P	S	Al	Сr	Сц	Ni	NЪ	v	N	VIII 1-3
G	0.12	0.42	1.90	0. 01	0.002	0.03	0. 47	0. 02	0.01	0.000	0.000	0. 003	
H	0. 15	0.41	1. 51	0.01	0. 003	0.04	0.42	0. 30	0.02	0.000	0.000	0.003	
1	0. 15	0.40	1.80	0. 01	0.002	0.03	0. 48	0.01	0. 01	0.010	0.000	0.004	発明材
ı	0. 18	0. 38	1.79	0.01	0.002	0. 03	0. 46	0. 01	0, 01	0.000	0. 000	0. 003	
L	0.18	0.41	1.81	0.01	0.001	0. 03	0. 44	0. 22	0. 01	0.000	0.000	0. 003	
K	0. 23	0. 40	1.82	9. 01	0. 002	0.03	0. 02	0. 01	0.02	0.000	0.000	0.003	比較材

# [0025] [A table 7]

	_												
				鳥	選 🖇	<b>人</b> 件			造質	条件	<u> </u>	粗糠	
蜘	番	AT 3		30%						輻紋		焼戻し	
	号	湿度	性上	压下	冷却	保持	卷取	板厚	外径	り串	<b>Q</b> /	マルテンサイト	借 考
			建度	温度	速度	時間	建度	t	D	Q	(t/D)2	分零	
		(°C)	ලා	(°C)	%/\$	(0)	(°C)	(mm)	(m)	<b>(%)</b>		(%)	
G	1	820	900	925	130	2.5	80	2.3	34.0	6.5	1420	100	
H	2	810	910	940	120	2.3	70	2.3	34.0	8.5	1420	100	
ī	а	810	880	905	125	2.8	60	2. 3	34.0	6.5	1420	100	発明例
J	4	800	890	915	110	2.2	70	2.3	34.0	6. 5	1420	100	
K	5	800	870	890	115	2.3	50	2.3	34.0	6.5	1420	100	
L	6	790	890	910	120	2.1	50	2.3	34.0	6. 5	1420	100	比較例

[0026] [A table 8]

	*	引張特性	耐水素差れ割れ特性	
#		TS	割れ発生限界付加	備考
	+	(N/==1)	歪み、Δε (μ)	
Α	1	1180	1900	
В	2	1360	2860	
С	3	1390	1900	発明例
D	4	1480	1900	
E	5	1500	2380	
P	6	1640	0	比較例

[0027] [A table 9]

				#8	延4	<b>集件</b>			进售	条件		組業	
#	番	Ar3		30%						釋校		焼灰し	
	号	温度	胜上	圧下	冷却	保持	卷取	板厚	外径	り字	Q/	マルテンサイト	● 考
) 1			温度	温度	速度	時間	湿皮	t	D	Q	(t/D)*	分率	
		(°C)	(°C)	(°C)	℃/a	<b>(s)</b>	_(°C)	<b>(=)</b>	(m)	(%)		<i>ଓ</i> ର_	
	7		850	870	90	2.3	70	2.3	38.1	3.9	1070	85	発明例
G	8	820	890	915	120	2.7	80	2.3	31.8	8.2	1.568	100	263121
٦	9	020	900	920	50	2.5	6D	2.8	3B, 1	3. 9	1070	8	比較例
	10		920	940	120	2.5	70	2. 3	31.8	4.8	918	100	HARLPI
	11		860	890	90	2.2	80	3.2	31.8	11.8	1165_	100	
1	12		B50	875	125	2.0	90	2.3	34.0	10.5	2295	100	発明例
H	13	810	850	870	95	2.1	60	3. 2	38.1	7.5	1063	100	
	14		810	830	90	2.3	100	2.3	38.1	3.9	1070	60	比較例
L	15		940	955	130	2.7	60	2.3	31.8	8.2	1588	100	PLANT
Γ	16		860	880	120	3.2	70	2.3	38. 1	3.9	1070	100	発明例
l ı	17	810	880	900	85	2.0	60	3.2	31.8	11.8	1165	100	767771
'	18	010	890	910	105	2.1	90	2.3	38.1	11.8	3238	100	比较例
L	19		860	880	80	>2,0	190	3.2	31.8	11.8	1165	*1	ALAEL VI
	20		890	915	120	2.3	80	23	38.1	3.9	1070	100	l
ŀ	21		900	930	115	2.7	70	2.0	34.0	9.5	2746	100	発明例
1	22	]	900	930	110	2.1	60	2.0	34.0	6.5	1879	100	363300
1	23	800	900	925	110	2.4	60	2.3	31.8	8.2	1568	100	L
i i	24	]	880	910	105	1.1	80	2.3	38.1	3. 9	1070	<b>*</b> 2	]_
ı	25	j	860	910	110	2.1	70	2.0	34.0	6.5	1879	100	比較例
L	26	<u>l</u>	890	910	100	2.1	60	2.0	38.1	9.6	3484	100	
Г	27		900	925	120	2.2	60	2.3	34.0	6.5	1420	100	発明例
k	28	800	850	880	105	2.1	80	2.0	31.8	7, 2	1820	100	元为内
١^	29	300	850	880	105	1.3	80	2.0	34.0	6.5	1879	*2	比较例
L	30	<u> </u>	840	865	90	2. 2	100	2.3	31.8	3.9	746	100	ILIOX P9

[0028] [A table 10]

П	番	引張特性	耐水素腫れ割れ特性		
無		TS	割れ発生服界付加	備 考	
	号	(N/==2)	歪み、Δε (μ)		
G	7	1040	1900	発明例	
	8	1210	1900	7.77	
ľ	9	810	1900	比較例	
	10	1120	950		
	11	1410	2860		
	12	1360	2860	発明例	
H	13	1320	2860		
	14	870	2860	比較例	
	15	1340	950		
	16	1270	1900	発明例	
1	17	1360	1900		
	18	1420	950	比較例	
L	19	940	1900		
	20	1480	1900		
1	21	1490	1900	発明例	
1	22	1510	1900		
)	23	1520	1900		
l	24	1510	950		
1	25	1500	950	比較例	
	26	1570	950		
	27	1480	2380	発明例	
K	28	1510	2380	1	
	29	1530	950	比較例	
L	30	1490	950		

[0029] [A table 11]

(wt. %)

#	С	S I	Mn	P	s	Αl	ИЪ	Cu	Сr	Ni	lio	Тi	В	N	Γ
M	0. 15	0. 35	L 78	0. 01	0. 005	0.03	0. 015	0. 22	0. 0 <del>2</del>	tr	4	tr	tr	0. 002	
N	0. 15	0.36	1. 40	0. 02	0. 003	0. 02	0.014	0. 40	Q 01	tr	tr	0. 01	D. 001	0. 003	i i
0	Q 17	0. 41	1. 80	0. 01	0. 003	0.03	0. 020	0. 16	Q. 01	tr	tr	tr	tr	0.004	٠.,
P	0. 17	0. 33	1. 35	0. 01	0. 001	0. 03	0. 016	0. 15	tr	밥	Ħ	0.01	0. 001	0.002	例
q	0. 17	0, 41	1. 82	0. 01	0. 002	0. 03	tr	0. 14	0. 42	tr	tt	0.01	0. 001	0. 003	
R	Q. 17	0. 40	1. 50	9. 01	0. 003	0.03	tr	tr	0. 03	ц	tr	tr	tr	0. 003	. –
s	0. 23	0. 37	1. 90	0. 01	0. 002	0. 03	tr	t <del>r</del>	0.03	ц	tr	묘	tr.	0. 003	較例

[0030] [A table 12]

a	スラブ→無延(インライン拡入れ焼戻し)→スリット→走管
β	スラブ→無延→連続焼鈍(インライン集入れ焼戻し)→スリット→造管
7	スラブ <del>→熱延→冷延→速視鏡</del> 輪(インライン換入れ焼戻し)→スリット→ <b>造</b> 管
8	スラブ→無延→スリット→造管→統入れ使戻し
8	スラブ→無尾→冷延→焼鉢→スリット→査管→焼入れ焼戻し

[0031] [A table 13]

			マルテンサイト	浸渍試験前	浸渍試験後			
	_						<b>務留發皮率</b>	
香号		製造方法	分率	ØTS	ØTS			
			(%)	(N/m²)				
1	M	α	8.0	1220	1040	8 5		
2	M	7	100	1420	1180	8.3		
3	M	8	100	1400	1200	8 6		
4	z	α	8 0	1410	1300	9 2		
5	N	7	100	1 2 30	1110	90		
6	N	δ	100	1380	1210	8.8		
7	0	α	100	1 5 30	125C	8 2		
8	0	τ	100	1520	1260	8.3	発明例	
9	0	δ	100	1470	1180	8.0		
10	0	ε	100	1550	1260	81		
11	P	α	100	1 4 5 0	1190	8 2		
12	P	β	100	1520	1260	8.8		
13	P	7	100	1550	1240	80		
14	P	δ	100	1540	1260	82		
15	Q	α	100	1560	1260	81		
16	Q	8	100	1530	1250	82		
17	R	α	100	1380	990	72		
18	R	β	100	1420	1040	7 3		
19	R	7	100	1500	1110	7 4		
20	R	8	100	1510	1120	7.4	比較例	
21	R		100	1500	1080	7 2		
22	s	a	80	1320	920	70	]	
23	s	7	100	1570	_	遅れ破壊割れ	1	
24	S	δ	100	1550	1010	6.5	1	

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#### **DESCRIPTION OF DRAWINGS**

[Brief Description of the Drawings]

[Drawing 1] Drawing showing the relation between Cu addition and crack generating marginal addition distortion variation.

[Drawing 2] Drawing showing the relation between nickel addition and crack generating marginal addition distortion variation.

[Drawing 3] Q/2 (t/D) Drawing showing relation with hydrogen delay crack generating marginal addition distortion.

[Drawing 4] The holding time and hydrogen delay crack generating marginal addition distortion deltaepsilonc in a 150-250-degree C temperature requirement Drawing showing relation.

[Drawing 5] Drawing showing the relation between Cu addition and the rate of retained strength after a corrosion test.

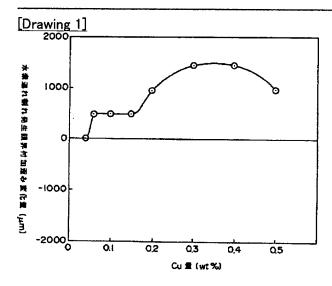
[Drawing 6] Drawing showing the relation between nickel addition and the rate of retained strength after a corrosion test.

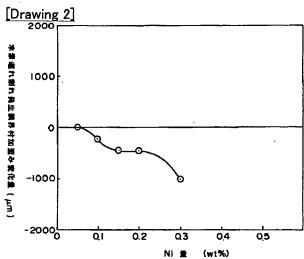
[Drawing 7] Drawing showing the relation between Mo addition and the rate of retained strength after a corrosion test.

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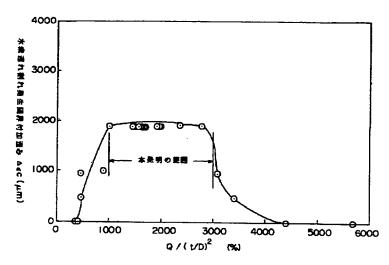
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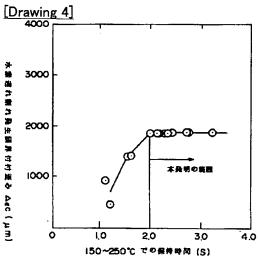
### **DRAWINGS**

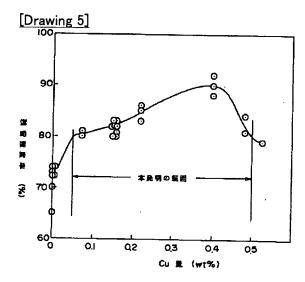




# [Drawing 3]







[Drawing 6]

